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(22)Date of filing : 20.08.1998 (72)Inventor : NODA TAKASHI

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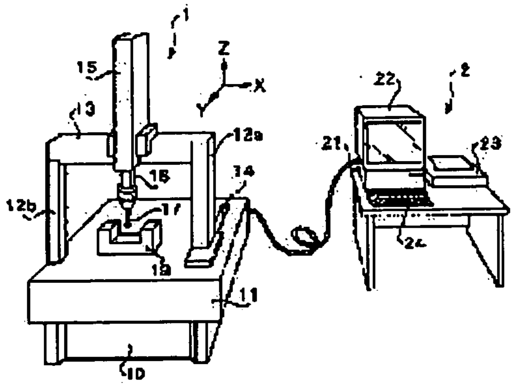
(54) THREE-DIMENSIONAL MEASURING MACHINE

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain an accurate measurement value by detecting contact speed and acceleration when a probe touches an object to be measured and generates warning when the measured values are outside a tolerance for prompting remeasurement.

SOLUTION: The parts of a probe 17 and a Z-axis arm 16 are gripped and the probe 17 is moved by manual operation, the tip ball of the probe 17 is brought into contact with each part of a work 19 and each part of the work is measured. In this case, the probe 17 is moved to precisely measure the axes of X, Y, and Z coordinate, and the deviation between X, Y, Z display values being displayed by a host system 2 and display values being measured precisely is calibrated. Then, by bringing the probe into contact with the specific surface of the object to be measured for several times by changing contact speed and acceleration, the tolerance table of the contact speed and acceleration is created from the measurement values. Then, the contact speed and acceleration when the probe 17 touches the object to be measured are detected, thus generating warning and prompting remeasurement when the detected values are out of a tolerance.


1
15
Z
X
Y
13
12a
16
14
12b
17
19
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24

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CLAIMS

[Claim(s)]

[Claim 1] In the three coordinate measuring machine with which the probe which moves in a three-dimensions space top contacts a device under test, outputs a contact signal, detects the location on the three-dimensions space of said probe at the time of the output of said contact signal, and measures said device under test The range table showing the tolerance of the contact rate to said device under test of said probe, and contact acceleration, A detection means to detect a contact rate and contact acceleration when said probe contacts said device under test, The three coordinate measuring machine characterized by generating warning and demanding remeasurement from an operator with reference to the contact rate and contact acceleration of said probe detected with a preparation and this detection means to said range table when it is outside tolerance.

[Claim 2] Said range table is a three coordinate measuring machine according to claim 1 characterized by being the table showing the tolerance of the contact rate and contact acceleration for every class of said probe.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the three coordinate measuring machine of the contact process which a probe is contacted to a device under test and obtains required measured value.

[0002]

[Description of the Prior Art] 2 of the approach according to CNC as an approach of measuring using a three coordinate measuring machine, and the approach by manual actuation There is a passage. The approach by CNC is an approach of driving a probe automatically by the program set up beforehand by the command from a host computer. Moreover, there are an approach of moving a probe by manual operation with the CNC three coordinate measuring machine which has a drive using the control panel with which the joy stick etc. was attached, and a method of moving a probe by the direct hand as approach by the manual.

[0003] Also in which approach, a three coordinate measuring machine detects a touch signal when a probe contacts a work piece, and incorporates the three-dimensions coordinate value of the probe at that time as measured value. In a common touch signal probe, if a probe (stylus) is supported by elastic support members, such as diaphram, to housing and a probe contacts a work piece, these supporter material carries out elastic deformation, the support shaft of a probe displaces, and the contact detection means attached in the support shaft will detect this variation rate, and will output a touch signal.

[0004]

[Problem(s) to be Solved by the Invention] However, the conventional three coordinate measuring machine, There is a problem that a measurement error when the passing speed of a probe is especially small is large. Especially in the case of manual measurement, it is clear statistically that the individual difference by the operator appears in a measurement result. As one of the cause of the, the difference of the contact rate of the flash when a probe contacts a work piece is mentioned. That is, a contact rate in case a probe contacts a work piece usually has common 3 - 20 mm/s extent, and measured value when a probe and a work piece contact at the rate beyond this shows the value stabilized mostly. However, if a contact rate is slower than this, it is checked that a gap arises on the probe coordinate incorporated at the time of touch signal detection and an original probe coordinate. Many of probes which are carrying out the current activity although the reason is not certain are 3 formed in a probe and one. It has structure which supported the pin of a book with six balls etc. Although at least one of these six balls will be in a non-contact condition and it detects this electrically when a probe contacted and displaces in a measurement object The direction when a probe displaces at a loose rate is considered that the amount of deflections until a contact separates will be large. Moreover, if a rate is not fixed and acceleration exists at the time of contact, it is thought that effect appears in the amount of deflections until a contact separates similarly. Therefore, if the acceleration at the time of contact changes, it is thought that the amount of deflections also changes.

[0005] Although it is controllable in a contact rate, since the travel of a probe becomes small inevitably in measuring the bore of a pinhole, for example, in the case of a CNC three coordinate measuring machine, a probe cannot fully be accelerated, but it cannot but measure with crawling in it. For this reason, the same problem as the above occurs also in a CNC three coordinate measuring machine. Moreover, when a travel is very small, it is in the middle of acceleration, and cannot but measure.

[0006] This invention was made in view of such a point, and when predetermined is out of range in a three coordinate measuring machine as for the range of the contact rate at the time of a probe contacting a device under test, and contact acceleration, warning is generated, remeasurement is demanded from an operator and it aims at offering the three coordinate measuring machine which can obtain more exact measured value.

[0007]

[Means for Solving the Problem] In order that this invention may attain said object, the probe which moves in a three-dimensions space top contacts a device under test, and outputs a contact signal. In the three coordinate measuring machine which detects the location on the three-dimensions space of said probe at the time of the output of said

contact signal, and measures said device under test The range table showing the tolerance of the contact rate to said device under test of said probe, and contact acceleration, A detection means to detect a contact rate and contact acceleration when said probe contacts said device under test, It is characterized by generating warning and demanding remeasurement from an operator with reference to the contact rate and contact acceleration of said probe detected with a preparation and this detection means to said range table, when it is outside tolerance.

[0008] Moreover, in addition to the above-mentioned means, this invention can constitute said range table also from it being the table showing the tolerance of the contact rate and contact acceleration for every class of said probe.

[0009] In addition, since it is thought that the relation of the measurement error over a contact rate and contact acceleration differs for every probe, as for a range table, it is desirable that it is what shows the tolerance of a contact rate and contact acceleration for every probe. Moreover, when using the probe head which attached two or more probes, it is necessary to ask for tolerance for every probe similarly.

[0010]

[Embodiment of the Invention] Hereafter, the gestalt of desirable implementation of this invention is explained with reference to a drawing. Drawing 1 is the perspective view showing the configuration of the three coordinate measuring machine of the manual measurement mold concerning one example of this invention. This three coordinate measuring machine incorporates required measured value from the body 1 of a three coordinate measuring machine, and this body 1 of a three coordinate measuring machine, and consists of host systems 2 for processing this.

[0011] The body 1 of a three coordinate measuring machine is constituted as follows. That is, on a shock absorbing desk 10, it is laid so that a surface plate 11 may make that top face a base side and it may be in agreement with the level surface, and the X-axis guide 13 is supported by the upper bed of the arm base materials 12a and 12b set up from the ends side of this surface plate 11. As for arm base material 12a, the soffit is arranged movable to Y shaft orientations along with the Y-axis guide 14, and, as for arm base material 12b, the soffit is supported by Y shaft orientations movable on the surface plate 11 by the pneumatic bearing. The X-axis guide 13 guides the Z-axis guide 15 prolonged perpendicularly to X shaft orientations. It is prepared so that the Z-axis arm 16 may move to the Z-axis guide 15 along with the Z-axis guide 15, and the soffit of the Z-axis arm 16 is equipped with the probe 17 of a contact process. When the work piece 19 with which this probe 17 was laid on the surface plate 12 is contacted, a touch signal is outputted to a host system 2 from a probe 17, and a host system 2 incorporates the

XYZ coordinate value at that time.

[0012] Drawing 2 is the block diagram of this three coordinate measuring machine. The XYZ shaft encoder 18 which outputs the migration pulse of each shaft orientations with migration of the XYZ shaft of a probe 17 is built in the body 1 of a three coordinate measuring machine.

[0013] The host system 2 consists of a counter 20, a host computer 21, and a monitor 22, a printer 23 and a keyboard 24. When a probe 17 contacts a work piece 19, a counter 20 latches the enumerated data of each shaft with the touch signal outputted from a probe 17, while carrying out counting of the pulse signal corresponding to each shaft from the XYZ shaft encoder 18 for every shaft. While a host computer 21 inputs the enumerated data latched to the counter 20 and changing this into the current position coordinate of a probe The migration direction, passing speed, and migration acceleration of a probe 17 are detected from the enumerated data of the counter 20 sampled at fixed spacing (as variation of passing speed). Furthermore, a detection means to detect a contact rate and contact acceleration when the touch signal from a probe 17 is detected and a probe 17 contacts a work piece 19 is constituted. Moreover, the range table 25 is built in the host computer 21. The range table 25 consists of EEPROMs eliminable electric etc., and as shown in drawing 3 , it memorizes the relation between the contact rate and contact acceleration to the work piece 19 of a probe 17, and a measurement error for every class of probe 17.

[0014] Next, actuation of the CNC three coordinate measuring machine constituted in this way is explained. In this three coordinate measuring machine, each part of a work piece 19 is measured by grasping the parts of a probe 17 or the Z-axis arm 16, moving a probe 17 by manual operation, and contacting the head ball of a probe 17 to each part of a work piece 19. Since a measurement error may occur depending on the contact rate and contact acceleration at that time, it asks for the range table 25 by the following actuation beforehand.

[0015] First, a work piece 19 is firmly fixed to a surface plate 11, a probe 17 is moved manually, and the specific field of a work piece 19 is made to contact. It considers as the free condition that distortion does not start a probe 17 in this condition. Next, in the condition, each shaft is fixed and a XYZ axis of coordinates is measured precisely using the well-known scale proofreading technique using a laser interferometer, the probe for proofreading, etc. And when the XYZ indicated value which it displayed with the host system 2, and the indicated value measured precisely have shifted, it proofreads to the value which had indicated value measured. Then, attach a probe 17 in the Z-axis arm 16, and it is made to contact several times, changing a contact rate and contact acceleration

into the above-mentioned specific field of a work piece 19, and the relation between the contact rate at that time and contact acceleration, and measured value is made to memorize in a host computer 21.

[0016] A host computer 21 asks for the curve which shows the relation between a contact rate, the amount of deflection (= measured-value-precise measurement value) and a contact rate as shown in drawing 4 , and repeatability sigma (standard deviation for which it asks using all measurement data) from the relation between the contact rate and contact acceleration which were obtained, and measured value with the least square method etc. And each shaft orientations can be asked for this curve about each probe, and the range table 25 showing the tolerance of a contact rate as shown in drawing 3 from the curve for which it asked, and contact acceleration can be created as range which fills simultaneously the threshold value (deltal) of the amount of deflection, and both of threshold value sigmat of repeatability.

[0017] For example, if it is V3<V1 and V4<V2 in drawing 4 (a) and (b), it will be set to V1-V4 as tolerance of a contact rate, and if it is alpha2<alpha1 in (c) of drawing 4 , and (d), it will be set to 0-alpha2 as tolerance of contact acceleration. Moreover, when the relation between a contact rate and contact acceleration, the amount of deflection, and repeatability is not dependent on a contact direction at all on the structure of a probe 17, it is not necessary to ask for the range for every shaft but, and when depending to a contact direction strongly, in quest of the range, the range table 25 is created for every shaft.

[0018] Drawing 5 is a flow chart which shows processing of the host computer 21 in actual measurement. This processing will be performed if a touch signal is inputted from a probe 17. First, the measured value at the touch signal input event (XYZ coordinate value) is incorporated (S1). Next, a contact rate and contact acceleration confirm whether to be within the limits on the range table 25, respectively (S2). Rate warning will be generated supposing the contact rate which contact rates are for example, 1.3 mm/s, and is registered into the range table 25 at this time is 3 - 20 mm/s (S3). moreover, contact acceleration -- 150mm/s2 it is -- the contact acceleration registered -- 0 - 100 mm/s2 it is -- if -- (S4) which generates acceleration warning. warning -- a screen -- "-- an alarm display is carried out in alphabetic characters, such as rate unsuitable" and "an excess of acceleration", and also it is possible to emit warning with a beep sound, the voice recorded beforehand, or voice including the language compounded in digital one.

[0019] Drawing 6 is drawing showing the example which applied this invention in a CNC three coordinate measuring machine. This three coordinate measuring machine is

equipped with the controller 5 for incorporating required measured value from the body 3 of a three coordinate measuring machine, and the control panel 6 for operating a three coordinate measuring machine 3 manually through this controller 5 while it carries out actuation control of the body 3 of a three coordinate measuring machine, and the body 3 of a three coordinate measuring machine other than a host system 4.

[0020] In the case of a CNC measurement machine, except for the point that the drive of each shaft is formed in the manual-type body 1 of a three coordinate measuring machine shown in drawing 1 , since other fundamental configurations are the same as that of the body 1 of a three coordinate measuring machine of drawing 1 , the body 3 of a three coordinate measuring machine gives the same agreement to a corresponding part, and omits detailed explanation. The soffit drives arm base material 12a to Y shaft orientations with the Y-axis drive 31. The X-axis guide 13 is formed so that it may drive along with the Z-axis guide 15 prolonged perpendicularly.

[0021] Drawing 7 is the block diagram of this three coordinate measuring machine. The XYZ shaft motor 32 for driving a probe 17 to XYZ shaft orientations is built in the body 3 of a three coordinate measuring machine. The joy stick 61 for driving the probe 17 of the body 3 of a three coordinate measuring machine by manual operation to XYZ shaft orientations and the coordinate value input switch 62 for inputting the XYZ coordinate value of the location of the current probe 17 into a controller 5 are formed in the control panel 6.

[0022] CPU51 is formed in a controller 5 and this CPU51 performs actuation control of a probe 17, incorporation control of a measurement value, etc. for it. That is, by the command of CPU51, the XYZ shaft actuation control section 52 drives the XYZ shaft motor 32 of the body 3 of a three coordinate measuring machine, the XYZ shaft counter 53 counts the pulse signal corresponding to each shaft from the XYZ shaft encoder 18, and it feeds back to CPU51 in quest of the current position. CPU51 performs actuation control of a probe 17 based on this feedback information. Moreover, CPU51 stops the XYZ shaft motor 32 following the touch signal from a probe 17.

[0023] From a control panel 6, the electrical-potential-difference value of the potentiometer corresponding to each shaft according to the dip direction and tilt angle of a joy stick 62 is outputted, and the migration direction and the rate decision section 54 of a controller 5 determine the migration direction, passing speed, and migration acceleration of a probe 17 according to the electrical-potential-difference value of each [these] shaft. Furthermore, the range table 25 mentioned above is formed in the interior of a controller 5.

[0024] Also in this example, since CPU51 carry out the warning check of the measured

value incorporated inside with reference to the range table 25 based on the contact direction, the contact rate, and contact acceleration of a probe 17 and a work piece 19, measurement in a high precision be attain also in automatical measurement of the pinhole which cannot fully take a contact rate or tend to be measure in an acceleration process, or the manual measurement by the control panel 6.

[0025] In addition, the range table 25 can also be created by the following approaches. Drawing 8 is drawing for explaining this approach. In the case of a CNC three coordinate measuring machine, it is (1). After attaching the probe 17 which should attach the master ball 71 whose diameter is known beforehand as shown in drawing 8 in the surface plate 11 of the body 3 of a three coordinate measuring machine, and should be measured first, probe information, such as a probe number, is inputted into a controller 5.

(2) Next, carry out multipoint (for example, four points) measurement of the master ball 71 with a probe 17, and search for the coordinate of the temporary central point of the master ball 71.

(3) Then, the master ball 71 is seen from a Z-axis plus direction, and a core [the temporary central point], while dividing 30 degrees at a time, each cross section is seen from the still more nearly vertical direction from each cross section, and the intersection of each parting line when dividing 30 degrees centering on [each] the temporary central point and the front face of the master ball 71 is computed with a host computer 71, and let these intersections be the lattice points P on the master ball 71. In addition, in this example, although the number of the lattice points P becomes 62 points, if the lattice point P is set up still more finely, warning detection precision will improve.

[0026] (4) A probe 17 is moved in the direction which goes to the temporary central point from each lattice point P next, multiple-times (for example, about 10 times) measurement of the coordinate of each lattice point P is carried out at a standard contact rate (for example, 5 mm/s), and the core of the master ball 71 is again searched for from the average-value coordinate of each obtained lattice point P, and let this be the true central point.

(5) Move a probe 17 in the direction which goes to the true central point from the lattice point P next, and measure the coordinate of each lattice point P. At this time, it changes 0.1 mm/s of contact rates at a time to for example, 0.1 mm/s - 50 mm/s extent about the same lattice point P, and the coordinate value of each lattice point P in each contact rate is calculated. here -- each rate -- about [10 time] measurement -- carrying out -- each rate -- it can set (average) -- it asks for repeatability sigma.

(6) Search for the difference of the distance from each lattice point P in each found

contact rate (average) to the true central point, and the distance from each lattice point P in a standard contact rate to the true central point, make this into the amount of deflection in each contact rate, and graph-ize it. Moreover, repeatability sigma is graph-ized similarly.

(7) a degree -- (5) (6) the same -- criteria [standard speed] -- carrying out -- acceleration -- 50 mm/s2 from -- 1000 mm/s2 up to extent -- 10 mm/s2 It is made to change every and graph-izes about acceleration.

(8) With the same approach as drawing 4 , it is allowed value [of the amount of deflection] sigma (l). Allowed value sigmat of repeatability It asks for the tolerance of a contact rate and contact acceleration as range which fills both simultaneously.

(9) By repeating the above activity about all the probes 17, the range table 25 showing the relation of the measurement error over probe information, a contact direction, a contact rate, and contact acceleration can be created.

[0027] Moreover, since a contact direction can be given finely in the case of the three coordinate measuring machine of a manual measurement mold or a probe 17 cannot be contacted at a specific contact rate, it carries out as follows.

(1) First, carry out multipoint measurement (as there is many point of measurement, it is better) of the master ball 71, and ask for the central point of the master ball 71.

(2) Next, measure by clamping the arm base materials 12a and 12b and the Z-axis arm 16 of a Y-axis, moving a probe 17 only to X shaft orientations based on Y of the called-for central point, and a Z coordinate, and making the master ball 71 contact with various rates and acceleration (changing a rate and acceleration consciously). Data processing of the contact rate can be carried out with the output of the XYZ shaft encoder 18 inputted serially, and it can be found, and as variation of a contact rate, data processing of the contact acceleration can be carried out, and it can ask for it. moreover, for example, a contact rate -- (0.1-5), (5.1-10), ... (40.1-45), and mm/s (45.1-50) -- like -- ten steps -- contact acceleration -- (0-100), (100.1-200), ... (800.1-900), and mm/s (900.1-1000)2 It classifies into ten steps like, and it measures until each number of data within the limits becomes ten or more.

(3) Perform measurement with the same said of a Y-axis and Z shaft orientations.

(4) Search for the difference of the die length from the calculated measured value (average value) in each range to the central point, and the radius (known) of the master ball 71 as an amount of deflection. Next, it asks for the curve which shows the relation between a contact rate and contact acceleration (making the core of each range into central value) as shown in drawing 4 , the amount of deflection, and repeatability, and asks for the tolerance of a contact rate and contact acceleration as range which fills

simultaneously both of the amount allowed value of deflection sigma(l) TO repeatability allowed value sigma t based on this curve, and the range table 25 is created.

[0028] According to this method, even if it does not use a laser interferometer etc., the range table 25 can be created with a sufficient precision.

[0029]

[Effect of the Invention] As stated above, according to this invention, measure beforehand the tolerance of the contact rate of a probe, and contact acceleration, investigate it, and the range table is created. Since warning will be taken out from a contact rate and contact acceleration when a probe contacts a device under test with reference to a range table if out of range, and he is trying to demand remeasurement from an operator If measurement actuation is carried out so that the amount of deflection may be settled in tolerance by remeasurement even if it changes the contact rate of a probe, and contact acceleration and separates from tolerance, the effectiveness that more exact measured value can be obtained will be done so.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the perspective view showing the configuration of the three coordinate measuring machine of the manual mold concerning one example of this invention.

[Drawing 2] It is the functional block diagram of this measurement machine.

[Drawing 3] It is drawing showing the content of the range table in this measurement machine.

[Drawing 4] They are the contact rate and contact acceleration in this measurement machine, the amount of displacement, and drawing showing relation with repeatability.

[Drawing 5] It is the flow chart which shows the warning detection processing at the time of the measurement in this measurement machine.

[Drawing 6] It is the perspective view showing the CNC three coordinate measuring machine concerning other examples of this invention.

[Drawing 7] It is the functional block diagram of this measurement machine.

[Drawing 8] It is drawing for explaining the creation approach of a range table.

[Description of Notations]

1 Three Body of a three coordinate measuring machine,

2 Four Host system,

5 Controller,

6 Control Panel,

19 Work piece.

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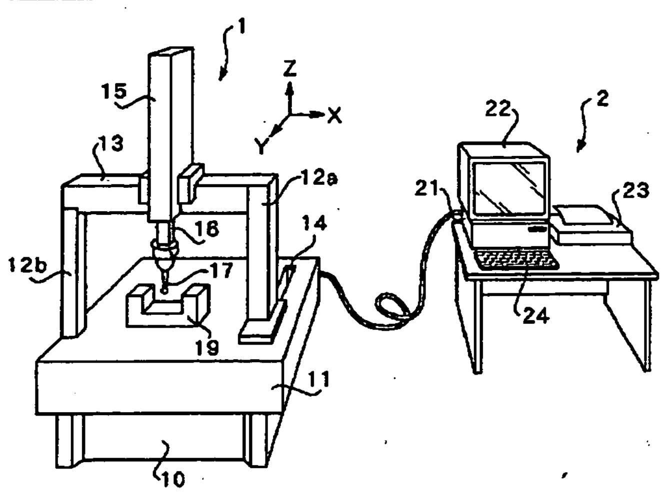
DRAWINGS

[Drawing 3]

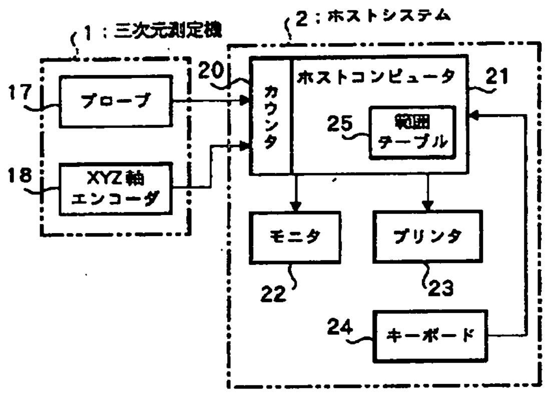
25 : 範囲テーブル

	プローブA			プローブB			......
接触速度 (mm/s)	3〜20	4〜15	3〜20	4〜15	5〜10	3〜20	......
接触加速度 (mm/s^2)	0〜90	0〜80	0〜100	0〜100	0〜100	0〜90	......

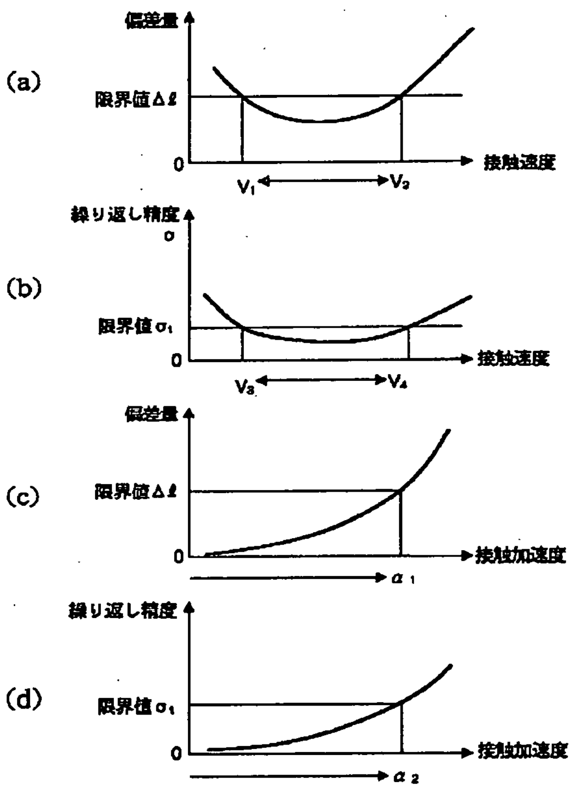
[Drawing 1]



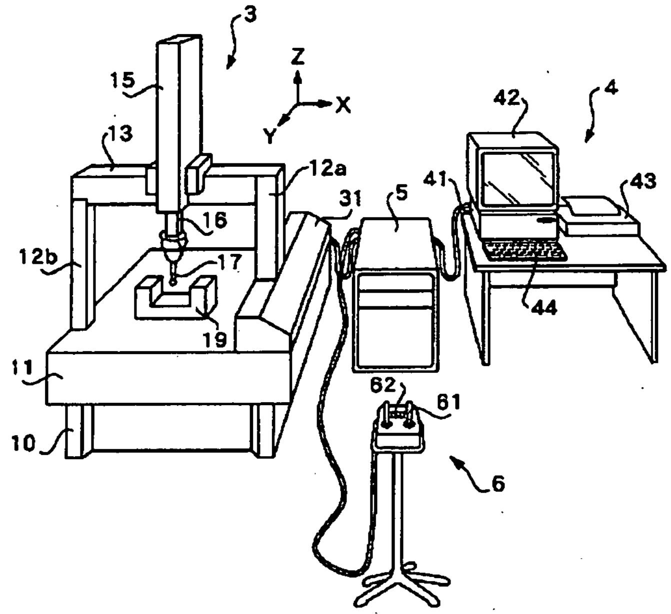
[Drawing 2]



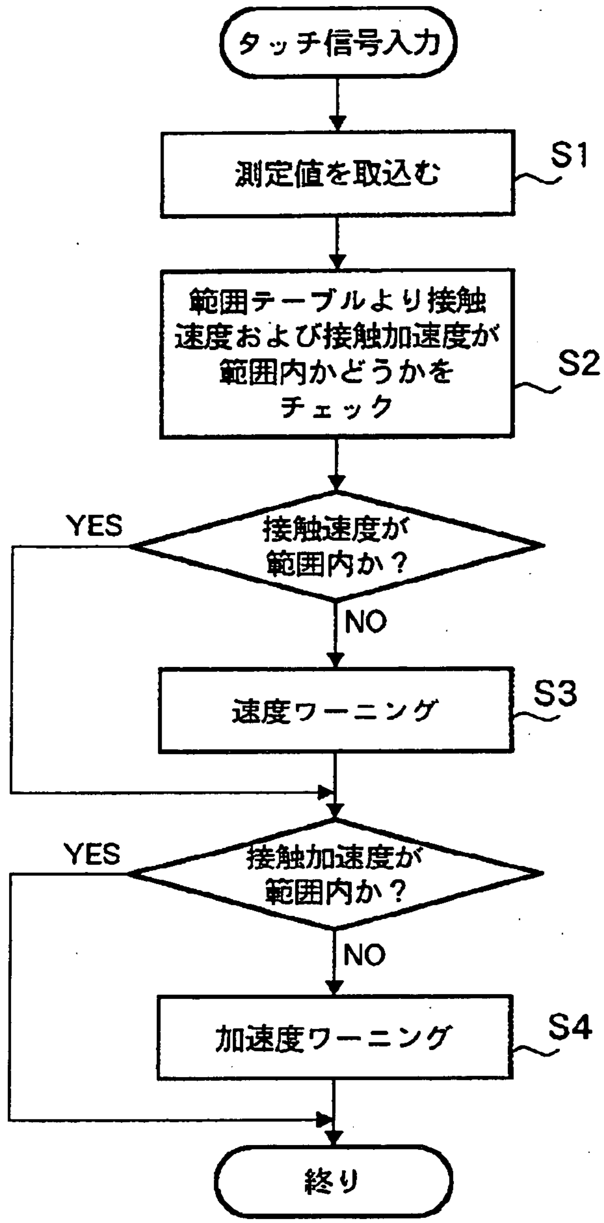
[Drawing 4]



[Drawing 6]



[Drawing 5]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測定値を取込む
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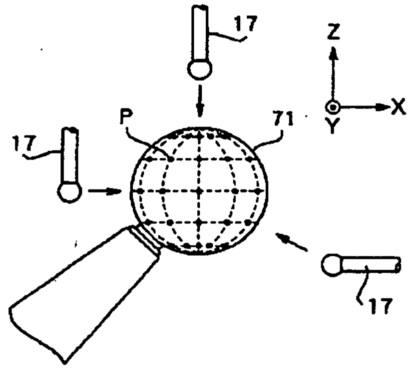
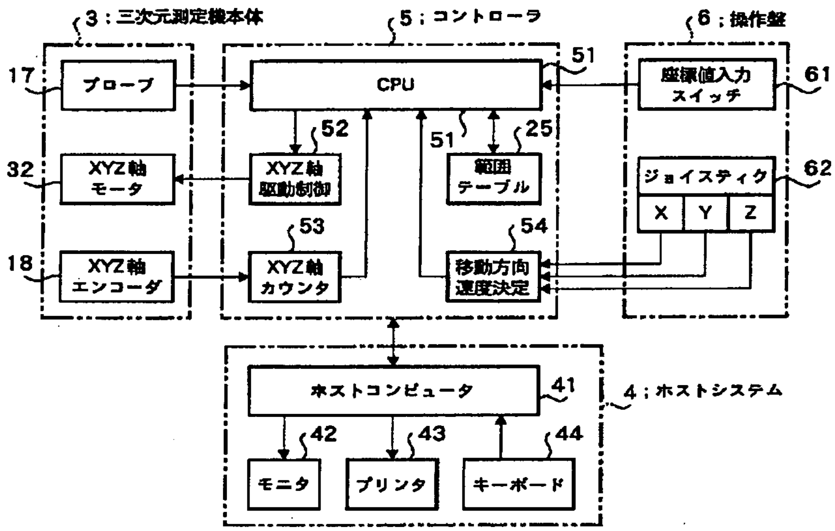
範囲テーブルより接触速度および接触加速度が範囲内かどうかをチェック
S2
接触速度が範囲内か？
YES
NO
速度ワーニング
S3
接触加速度が範囲内か？
YES
NO
加速度ワーニング
S4
終り

[Drawing 8]



[Drawing 7]



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